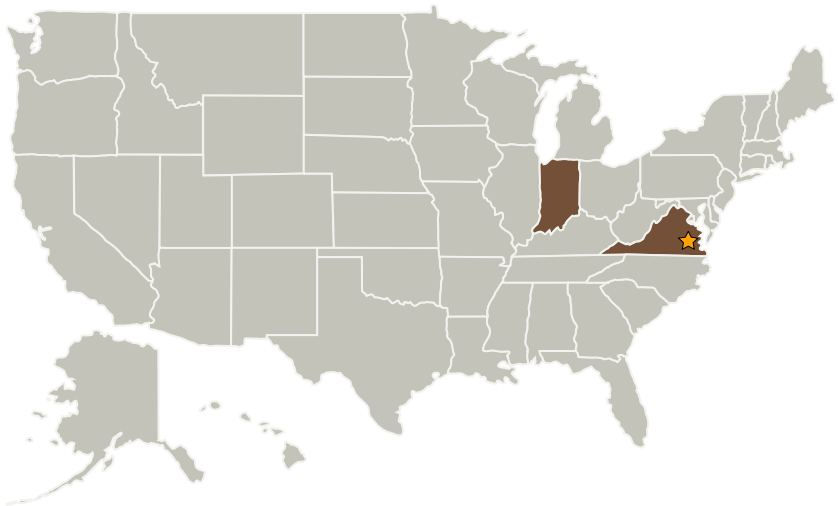
Efficient Radiation Simulation in Complex Geometries with Applications to Planetary Entry, Phase I

Completed Technology Project (2008 - 2008)

Project Introduction

NASA aerocapture missions require an accurate evaluation of radiative thermal transport in order to simulate the aerothermal environment around space vehicles. However, present day computation of radiative transport in this complex multi-dimensional environment is frequently done using simple one-dimensional tangent-slab approximations or optically-thick approximations which compromise the accuracy of predictions and which cannot be generalized to new vehicle configurations. In this Phase I proposal, we seek to develop an efficient and accurate unstructured solution-adaptive finite volume solver for participating radiation in complex geometries to address the aerothermodynamics of realistic space vehicles. A number of innovations are proposed to significantly accelerate solver performance over conventional implementations: (i) a spectral line weighted sum of gray gases model for property computation which is significantly faster than conventional line-by-line techniques, (ii) algorithmic improvements based on coupled algebraic multigrid and multiplicative correction techniques, and (iii) parallel implementations on both distributed and shared memory platforms, including new multicore architectures. The proposed framework is fully compatible with computational fluid dynamics (CFD) methods for flow, heat transfer, turbulence and chemistry, and coupling to these is proposed for Phase II. The project team consists of Drs. Sanjay Mathur of Jabiru Software and Services, and Prof. Jayathi Murthy of Purdue's School of Mechanical Engineering. The team is highly experienced in the development of large-scale commercial finite volume solvers, radiative heat transfer, and algorithm development, and has over two decades each of experience in the development and commercialization of large-scale CFD codes.

Primary U.S. Work Locations and Key Partners



Efficient Radiation Simulation in Complex Geometries with Applications to Planetary Entry, Phase I

Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Organizational Responsibility	1
Project Management	2
Technology Areas	2

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Efficient Radiation Simulation in Complex Geometries with Applications to Planetary Entry, Phase I

Completed Technology Project (2008 - 2008)

Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Jabiru Software and Services	Supporting Organization	Industry	West Lafayette, Indiana

Primary U.S. Work Locations	
Indiana	Virginia

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Sanjay R Mathur

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.2 Aerothermodynamics